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Wave Overtopping Analysis

Wave Overtopping Analysis accounts for the effects of wave overtopping when analyzing levees, flood walls or tidal barriers. The purpose is to account for damage in the floodplain due to waves spilling over the top of new levees or floodwalls and to account for waves when considering levees subject to failure.

New Levees and Floodwalls

New levees and floodwalls are generally, by design, not subject to failure below their crest. These structures can be subjected to wave action from large rivers or estuaries or in coastal areas. If wave action is shown to cause flood inundation damage, a wave overtopping analysis may be warranted. The HEC-FDA program includes a simplified approach to evaluate damage caused by wave overtopping.

Wave overtopping analysis is defined under Hydrologic Engineering, Levee Features. See Figure D.1.

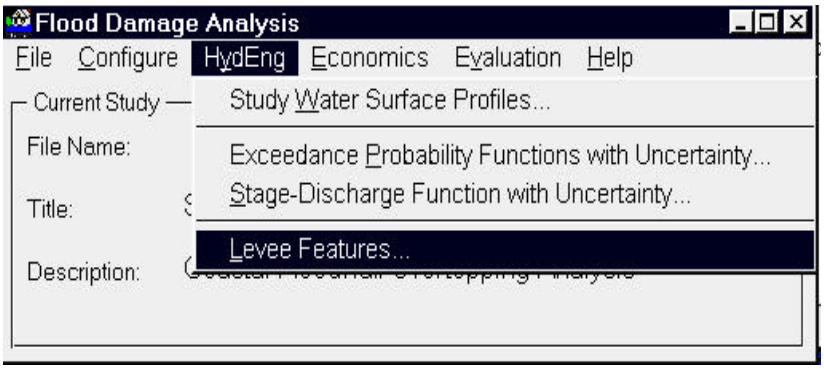

Figure D.1 Levee Features

The first step is to select the appropriate plan, year, stream, and reach where the levee or floodwall is currently or planned to be located. The top-of-levee stage is entered as shown in Figure D.2.

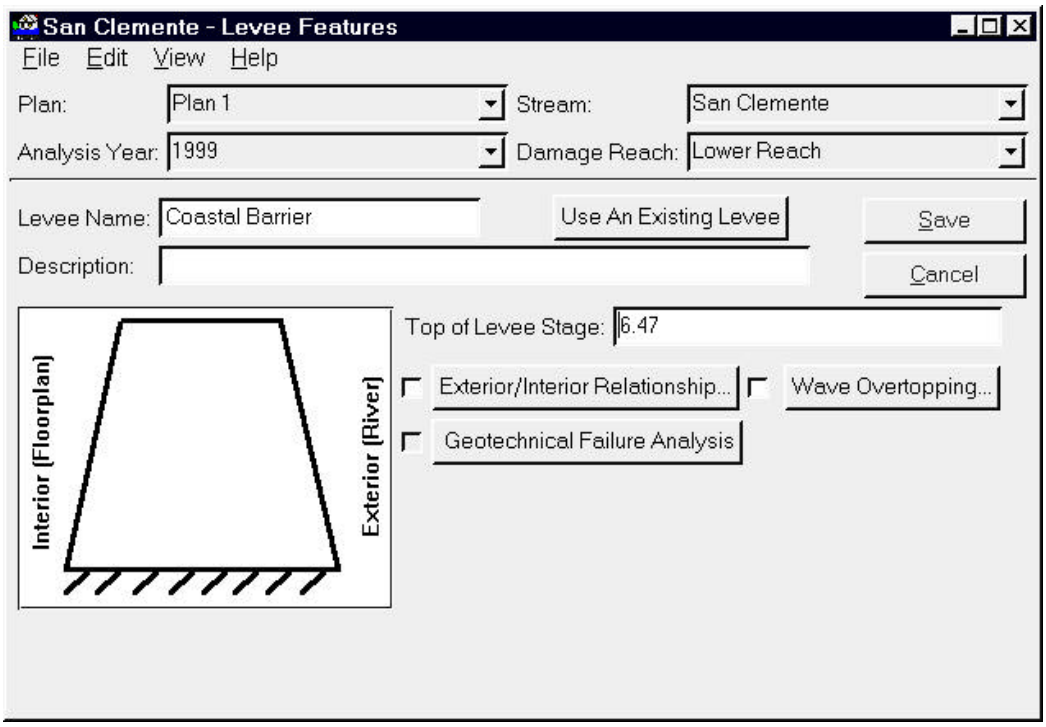

Figure D.2 Specifying Top-of-Levee Stage

Levee geotechnical failure analysis is not used for the new levee or floodwall, but it is assumed that the structure is subjected to waves that can overtop and cause damage to improvements in the floodplain. The "Wave Overtopping" button is pressed to display the screen shown in Figure D.3. The "Wave Height Functions" tab is selected and a still water level versus wave height relationship entered in the table. Still water stage corresponds to the exterior stage-discharge or stage-frequency function specified for the damage reach. The uncertainty of wave height is defined by selecting "Distribution Type." The parameters for the uncertainty distribution are entered in the table for each wave height.

The still water vs. wave height relationship and uncertainty are developed outside the HEC-FDA program from historical data and statistical analysis or by some other method. The expected wave height for a specific still water level is determined and the error distribution of wave heights defined. These data are entered and saved. A plot or table report of the relationships can be displayed.

When a levee or flood wall is subjected to wave action, a portion of the wave may overtop depending on whether the wave strikes the structure. The volume of water that spills over the levee or floodwall is dependent on the effective overtopping height. Once the still water level vs. wave height relationship has been defined, the Overtopping Parameters tab is selected to enter relationships for determining the effective overtopping and resulting depth in the floodplain. This tabs election is only available if geotechnical failure relationships have not been defined for this levee.

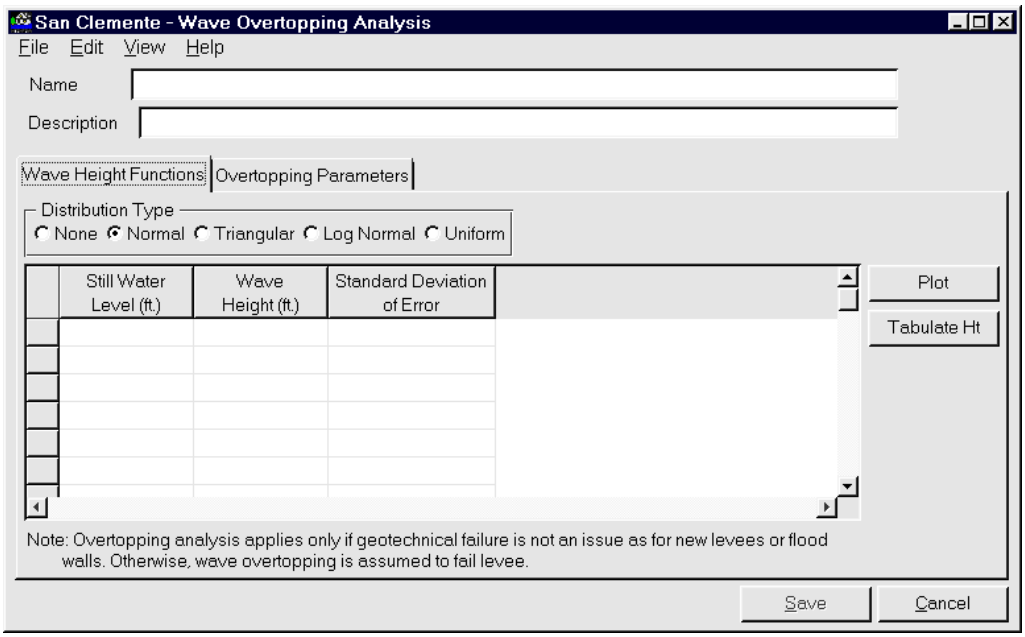

Figure D.3 Still Water Level vs. Wave Height

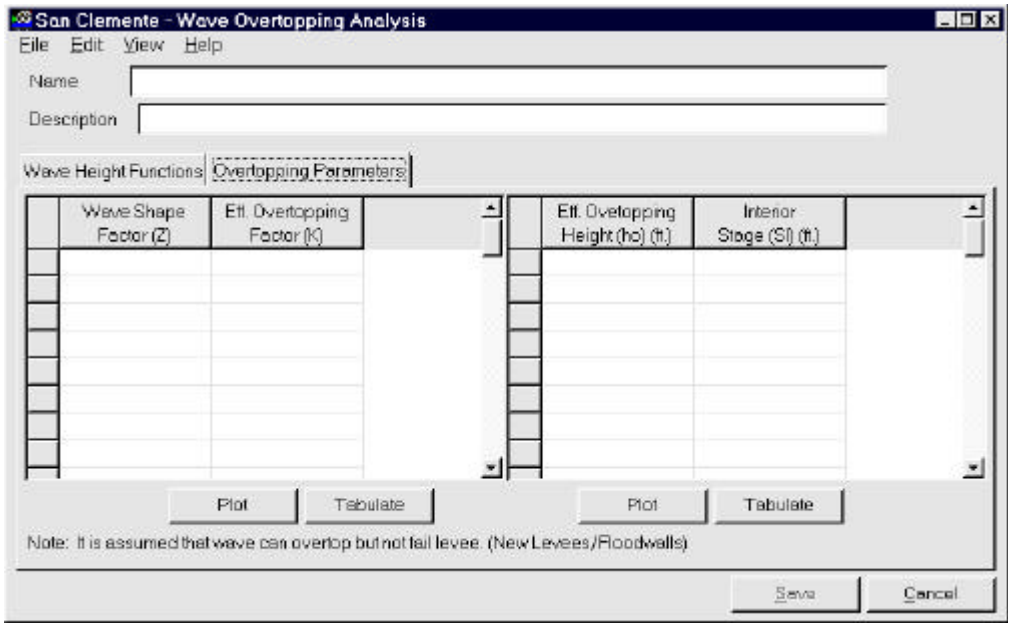

Figure D.4 Wave Overtopping Parameters

The screen for entering overtopping parameters is shown in Figure D.4.

These relationships are developed outside the HEC-FDA program from known wave characteristics and hydraulic analyses. The data in the two tables define separate

relationships. The following describes how the wave height and these data are used to determine the depth in the floodplain due to wave overtopping.

- Wave height (R) is determined from the still water level (SE) vs. wave height and uncertainty relationships for each still water level.

- If the still water level alone exceeds the top-of-levee (SD), wave runup (RR) is equal to two-thirds of the wave height. If still water level alone (SE) is below the top-of-levee, wave runup is equal to the full wave height.

  $RR = 2/3\ R \quad (SE \geq SD)$
  $RR = R \quad (SE < SD)$

- The exterior stage with wave (S_E) is computed by adding runup to still water level.

  $S_E = SE + RR$

- The total height above the levee (HW) is determined by subtracting the levee crest elevation (SD) from the exterior stage with wave (S_E). This height is set to zero if the exterior stage with wave is equal to or below the top-of-levee.

  $HW = S_E - SD \quad (SE > SD)$
  $HW = 0 \quad (S_E \leq SD)$

- The wave shape factor (Z) is equal to the ratio of the portion of wave above the levee or floodwall to total wave height and is determined by dividing the total height by the wave runup.

  $Z = HW/RR$

- K, is a factor for determining the portion of the total water above the top-of-levee that is effective for overtopping and is dependant on the wave shape factor, Z, as defined by the entered relationship Z vs. K. (Figure D.4.)

- The total effective overtopping height (HO) above the top-of-levee is equal to K times the total height (HW) above the top-of-levee.

  $HO = K*HW$

- The depth of water in the floodplain, referred to as interior stage (S_I) is the stage on the landward side or interior of the levee or floodwall and is dependant on HO as described by the entered relationship HO vs. S_I. (Figure D.4.)

These described relationships are entered and saved. It should be noted that the relationship HO vs. S_I should be defined for the full range of overtopping heights and interior stages. At some point, either by failure or sufficient overtopping , S_I should equal the levee elevation (SD) plus the quantity (HO minus 2/3 R).

S_I ==> SD + (HO - 2/3 R)

The exception would be if there was not sufficient volume available to fill the interior area to the same elevation as the exterior still water level.

Levees Subject to Geotechnical Failure

For existing levees or other levees subject to geotechnical failure, a relationship between stage on the exterior side of the levee and the combined probability of failure can be defined as described in the main portion of this document by selecting the "Geotechnical Failure Analysis" button on the opening Levee Feature screen. See Figure D.2. When this is the case, a still water level vs. wave height relationship may be defined to account for the effect of waves contributing to levee failure. The wave "Overtopping Parameters" tab is not available since waves are assumed to contribute to levee failure, and not overtopping.

When a still water level vs. wave height relationship is provided, the following two scenarios apply.

- If a given still water level fails the levee based on the geotechnical failure relationship, wave height is ignored and the still water level without wave is used to determine interior stage based on an exterior vs. interior relationship. If the later relationship is not provided, the interior stage is assumed equal to the still water level.

- If the still water level does not fail the levee based on the geotechnical failure relationship, sampled wave height is added to the still water level and compared to the top-of-levee stage. If still water level plus wave height is equal to or exceeds the top-of-levee, the levee is failed and the still water level without wave is used to determine interior stage based on an exterior vs. interior relationship. If the later relationship is not provided, the interior stage is assumed equal to the still water level.